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Request for grant of a patent

06 APR 2000

The Patent Office

Cardiff Road
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Gwent NP9 1RH

1.	Your reference	DL-P538
2.	Patent application number	0008318.8
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	DISCREET LOGIC INC 10 Duke Street Montreal Quebec Canada H3C 2L7
	Patents ADP number *(if you know it)*	7717572001
	If the applicant is a corporate body, give the country/state of its incorporation	Quebec, Canada
4.	Title of the invention	Network System For Image Data
5.	Name of your agent	ATKINSON BURRINGTON
	"Address for service" in the United Kingdom to which all correspondence should be sent	The Technology Park Shirland Lane Sheffield S9 3PA GB
	Telephone No:	0114 242 4581
	Patents ADP number	7807043001

		Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	N/A	N/A	N/A

		Number of earlier application	Date of filing (day/*month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	N/A	N/A

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request?	Yes

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9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	18
Claim(s)	07
Abstract	01
Drawings	10 +10

10. If you are also filing any of the following, state how many against each item.

Priority documents	N/A
Translations of priority documents	N/A
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	None
Request for preliminary examination and search *(Patents Form 9/77)*	None
Request for substantive examination *(Patents Form 10/77)*	None
Any other documents *(Please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature

Date **Wednesday, 05 April 2000**

12. Name and daytime telephone number of person to contact in the United Kingdom

RALPH ATKINSON CPA
0114 242 4581

LA-04-036

Network System for Image Data

Field of the Invention

The present invention relates to a network system for image data processing systems, in which image data is shared between a plurality of image processing systems.

Background of the Invention

Networks for image data processing systems are known that use standard distribution protocols, such Ethernet, TCP/IP and HiPPI. In video facilities houses, video data is often conveyed between machines using digital video tape or similar magnetic storage media. This provides a relatively inexpensive way of conveying data between stations and is beneficial particularly when image data is to be archived. It is also satisfactory if image data processing is to be performed at a single station, whereafter the material will often leave the facility house altogether.

A recent trend has been towards having a plurality of different stations within a facilities house therefore it has been appreciated that highly powered stations, having relatively high hourly charges, may be used for specific operations where a high degree of processing power is required. However, overall charges may be reduced by performing less demanding tasks at more modest stations. However, a problem with this approach is that the data must be transferred from one station to another and the act of transferring data, with its inherent time requirement, may off-set any gains made by using less expensive stations to perform particular tasks.

As previously stated, it is known to convey video image data over internal networks but given known approaches, high bandwidth networks,

such as HiPPI, are relatively expensive, which again off-sets any financial advantage made from transferring data between stations. Alternatively, it is known to convey data over TCP/IP networks but under these circumstances the rate of data transfer is relatively low, whereas the amount of data required to be transferred is usually relatively high, particularly when manipulating high bandwidth images, such as high definition TV (HDTV). Increasingly, in video facilities houses, HDTV images and images of even higher bandwidth, are being manipulated, particularly when source material is obtained by scanning cinematographic film.

Thus, in order to make best use of available hardware, it is preferable to transfer data over networks, preferably by making storage devices accessible to a plurality of stations. However, a problem arises in that known techniques will often off-set any commercial advantages gained from an ability to transfer data between stations.

Brief Summary of the Invention

According to an aspect of the present invention, there is provided a networked image data processing environment, comprising a plurality of image data processing systems; a plurality of data storage systems, wherein each of said data storage systems is operated under the direct control of one of said image processing systems; a high bandwidth switching means connected to each of said data processing systems; a low bandwidth network connected to said image processing systems and to said switching means, by which one of said processing systems controls the operation of said switching means and in which a first processing system requests access to a data storage system controlled by a second processing system over said low bandwidth network; said second processing system makes an identification

of storage regions that may be accessed by said first processing system; said second processing system conveys said identification to said first processing system over said low bandwidth network; and said first processing system accesses said identified storage portion via said high bandwidth switching means.

Brief Description of the Several Views of the Drawings

Figure 1 shows an image data processing system;

Figure 2 illustrates image frames of the type processed by the system shown in *Figure 1*;

Figure 3 illustrates a redundant array of inexpensive disks accessed by a fibre channel interface;

Figure 4 illustrates a known network configuration connecting systems of the type shown in *Figure 1*;

Figure 5 shows a networked image data processing environment embodying the present invention;

Figure 6 shows a request thread executed by a requesting processor;

Figure 7 illustrates a data request demon executed by a supplying processor;

Figure 8 shows an alternative network environment embodying the present invention;

Figure 9 illustrates an off-line processing system of the type shown in *Figure 8*; and

Figure 10 illustrates a high definition image processing system of the type shown in *Figure 8*.

Best Mode for Carrying Out the Invention

An image data processing system is illustrated in *Figure 1* consisting of a silicon graphics octane computer **101** configured to receive manual input signals from manual input devices **102** (such as a keyboard, mouse, stylus and touch tablet etc) and is arranged to supply output signals to a display monitor **103**. Operating instructions are loaded into the octane computer **101**, and thereafter stored on a local disk, via a data carrying medium, such as a CD ROM **104** receivable within a CD ROM reader **105**. Program instructions are stored locally within the octane **101** but frames of image data are stored on a RAID (Redundant Array of Inexpensive Disks) system via a fibre channel interface **106**. RAID calculations are performed by the octane **101** and data values are addressed so as to effect striping of image frames over the disk array.

A plurality of video image frames **201**, **202**, **203**, **204** etc are illustrated in *Figure 2*. Each frame in the clip has a unique frame identification (frame ID) such that, in a system containing many clips, each frame may be uniquely identified. In a system operating with standard broadcast quality images, each frame consumes approximately one megabyte of data. Thus, by conventional computing standards, frames are relatively large therefore even on a relatively large disk array, the total number of frames that may be stored is ultimately limited. However, an advantage of this situation is that it is not necessary to establish a sophisticated directory system thereby assisting in terms of frame identification and access.

As octane **101** boots up, it mounts its associated file system and takes control of data stored at the beginning of the storage device describing object allocation for the file system in an area referred to as a superblock. The superblock describes the frames that are available within

the file system and in particular maps frame ID's (identifications) to physical storage locations within the disk system. Thus, as illustrated in *Figure 2*, frame ID101 is stored at location **101**, frame ID102 is at location **102** and frame ID103 is at location **103** etc. Thus, if an application identifies a particular frame, it is possible for the system to convert this to a physical location within disk storage.

Fibre channel interface **106** communicates with a redundant array of disks **301** as illustrated in *Figure 3*. The array **301** includes six physical hard disk drives, illustrated diagrammatically as drives **310**, **311**, **312**, **313** and **314**. In addition to these five disks, configured to receive image data, a sixth redundant disk **315** is provided.

An image field **317**, stored in a buffer within memory, is divided into five stripes, identified as stripe zero, stripe one, stripe two, stripe three and stripe four. The addressing of data from these stripes occurs using similar address values with multiples of an off-set value applied to each individual stripe. Thus, while data is being read from stripe zero, similar address values read data from stripe one but with a unity off-set. Similarly, the same address values are used to read data from stripe two with a two unit off-set, with stripe three having a three unit off-set and stripe four having a four unit off-set. In a system having many storage devices of this type and with data being transferred between storage devices, a similar striping off-set is used on each system.

As similar data locations are being addressed within each stripe, the resulting data read from the stripes is XORd together by process **318**, resulting in redundant parity data being written to the sixth drive **315**. Thus, as is well known in the art, if any of disk drives **310** to **315** should fail, it is possible to reconstitute the missing data by performing a XOR operation

upon the remaining data. Thus, in the configuration shown in *Figure 3*, it is possible for a damaged disk to be removed, replaced by a new disk and the missing data to be re-established by the XORing process. Such a procedure for the reconstitution of data in this way is usually referred to as disk healing.

Systems of the type shown in *Figure 1* may be connected together via network configuration as shown in *Figure 4*. Each image data processing system **401**, **402**, **403** and **404** is substantially similar to the system shown in *Figure 1*. Each communicates with a respective disk array **411**, **412**, **413**, **414** over a respective fibre channel **431**, **432**, **433**, **434**. As shown in *Figure 1*, each system, such as system **401** includes an octane processor **441**, input devices **442** and a monitor **443**.

Each processor, such as processor **441**, includes a network card to facilitate network communication over an Ethernet network **445**. A program facilitating network communication remains resident on each processing system **441** enabling systems to respond to requests made from other systems. In this way, it is possible for system **401**, for example, to receive image data from, for example, disk storage array **413**. To achieve this, processor **441** makes a request over network **445** to the processor of system **403**. A demon running on system **403** catches this request and locally determines whether it is possible for the image data to be supplied to system **401**. If it is possible to supply the data, the data is read from disk storage **413** locally to system **403** and then transmitted over the Ethernet **445** to system **401**. At system **401**, the data may be buffered locally to storage **411** whereafter manipulations may be performed upon the data in real-time. However, it should be appreciated that the transfer of data over Ethernet **445** occurs at a rate substantially less than real-time.

It is possible to install higher bandwidth networks but these are expensive and tend not to be deployed. If a large amount of data is to be transferred, it may be preferable to store the data onto removable media, such as magnetic tape and thereafter physically transfer it to another station. However, this does require duplication of the data and procedures must be effected to ensure that the most up to date versions of material may be identified and accessed.

A networked image data processing environment embodying the present invention is illustrated in *Figure 5*. The embodiment includes eight image data processing systems **501**, **502**, **503**, **504**, **505**, **506**, **507**, **508** each having a respective disk array storage system **511**, **512**, **513**, **514**, **515**, **516**, **517** and **518**. Each of the image data processing systems **501** to **508** is substantially similar to image data processing system **401** etc shown in *Figure 4*. Each of the data storage systems is operated under the direct control of its respective image processing system. Thus, data storage system **511** is operated under the direct control of data processing system **501**. In this respect, data processing system **501** behaves in a substantially similar manner to data processing system **401** and data storage system **511** behaves in a substantially similar manner to storage system **411**. For example, each storage system **511** to **518** may be of the type obtainable from the present Assignee under the trademark "STONE" providing sixteen disks each having nine G-bytes of storage.

The environment includes a sixteen port non-blocking fibre channel switch type **521**, such as the type made available under the trademarks "VIXEL" or "ENCORE". Switches of this type are known for providing high bandwidth access to file serving systems but in the present embodiment, the switch has been employed within the data processing environment to allow

fast full bandwidth accessibility between each host processor **501** to **508** and each storage system **511** to **518**. Each data processing system **501** to **508** is connected to the fibre channel switch by a respective fibre channel **531** to **538**. Similarly, each storage system is connected to the fibre channel switch via a respective fibre channel **541** to **548**. In addition, an Ethernet network **551**, substantially similar to network **445** of *Figure 4*, allows communication between the data processing systems **501** to **508** and the fibre channel switch **521**.

Within the environment, a single processing system, such as system **501**, is selected as channel switch master. Under these conditions, it is not necessary for all of the processing systems to be operational but the master system **501** must be operational before communication can take place through the switch. However, in most operational environments, all of the processing systems would remain operational unless taken off-line for maintenance or upgrade etc. Master processor **501** communicates with the fibre channel switch **521** over the Ethernet network **551**. Commands issued by processor **501** to the fibre channel switch define physical switch connections between processing systems and the disk storage arrays **511** to **518**.

On start-up, the switch **521** is placed in a default condition to the effect that each processor is connected through the switch **521** to its respective storage system. Thus, on booting up processing system **502**, for example, it mounts its own respective storage system **512** and takes control of the superblock defining the position of images held on that storage system, as illustrated in *Figure 2*. Thus, each processing system **501** to **508** takes control of its respective data storage system such that each storage system **511** to **518** runs under the control of its respective host. Thus, another processing

system, such as system **507**, may only gain access to storage system **512** if it is allowed to do so by its host data processing system **502**.

It is not possible for data processing system **507** to mount the superblock of storage system **512** or any of the other storage systems with the exception of its own storage system **517**. In theory, this could be possible but the procedures operated by the data processing systems are configured so as to prevent this, thereby maintaining data integrity.

A request to gain access to an alternative data storage system is made over Ethernet connection **511**. Again, a demon runs on each of the processing systems in order to respond to these requests and the procedures formed are substantially similar to the procedures executed by the environment described with respect to *Figure 4*. Thus, data processing system **507** may issue a request over Ethernet **551** to data processing system **502** to the effect that processor **507** requires access to storage system **512**, that is primarily under control of data processing system **502**.

Within the previous environment, processes executed by data processing system **502** and system **507** could effect a direct memory access to processing system **507** over Ethernet **551** but, as previously stated, this would not occur in real-time (that is, at video display rate). However, in the present embodiment, once it has been established that processor **507** may modify particular frames stored on storage system **502**, processor **502** makes a request to control processor **501** which in turn effects a modification to the fibre channel switch **521**. The non-blocking switch **521** provides a full bandwidth fibre channel between fibre channel interface **542** and fibre channel interface **537**.

By providing full bandwidth access to the storage system of other hosts, substantial advantages are gained in terms of a reduction of data

copying and transfer and an ability to process data stored elsewhere in a fashion similar to the processing of local data. Thus, with full bandwidth access provided by the fibre channel switch **521**, it is possible to perform real-time effects, previously only implemented using local storage, while accessing remote data again providing significant time savings and storage optimisations.

An example has been described in which processor **507**, a host to storage system **517**, requests frames of data from storage system **512**, hosted by processing system **502**. Processing system **502** retains control of storage system **512** therefore in order for processing system **507** to gain access to storage system **502**, it is necessary for procedures to be executed, in the form of a request thread, on processor **507** and for procedures, in the form of a response demon, to be executed on processor **502**.

A request thread, executed by processor **507** in the example but generally executable by all processors in the environment, is detailed in *Figure 6*. A thread is initiated at step **601** whereafter at step **602** a fame identification for the remote data required is identified. Thereafter, at step **603** the host processor responsible for this data is identified which, in this example, is host processor **502**.

At step **604** a request is made by host processor **507** over Ethernet connection **551** to host processor **502**. This request includes data receivable by processor **502** to the effect that host processor **507** requires access to specific frames held on storage system **512**.

In response to this request, host processor **502** may allow processor **507** to access storage system **512** through the fibre channel switch **521**. Alternatively, processor **502** may require full bandwidth access to storage system **512** itself and under these circumstances it may refuse to give

processor **507** access to its storage system. Thus, at processor **507** a question is asked as to whether the remote host (**502** in this example) will release access to its disk system (system **512** in this example). If the question is answered in the negative, a question is asked at step **606** as to whether a further request is to be made in an attempt to gain access and if this is answered in the affirmative, control is returned to step **604**. The system would be programmed to make several attempts and the actual number of attempts made before no further attempts are made is a detail of implementation. If it is decided that no further attempts will be made, control is directed to step **612** where the thread ends.

If the remote host processor is prepared to give access to its disk storage system, the question asked at step **605** will be answered in the affirmative and control will be directed to step **607**.

The requesting processor **507** supplies a frame identification or identifications for a plurality of frames making up a continuous clip. Thus, for example, processor **507** may submit a request to processor **502**, over Ethernet connection **551**, to the effect that it requires access to frames with frame ID's ID101 to ID105, as shown in *Figure 2*. Host processor **502** then consults the superblock of its mounted storage system **512** to determine that frame ID101 is at location LOC101, and so on until frame identification ID105 which is located at location LOC105. This information is then returned back to the requesting processor **507**, as shown at step **607** to the effect that details of the storage location have been received.

At step **607** processor **507** issues a request to the effect that a storage switchover is required. This request is made via control processor **501** which in turn issues a command to fibre channel switch **521** resulting in a disconnection of storage system **542** to processing system **502** and a

connection of storage system **542** to the requesting host processing system **507**. With this connection in place, processing system **507** theoretically has full access at full bandwidth to storage system **512**. However, instructions executed by processing system **507** are such that, although processing system **507** has full bandwidth access to storage system **512**, it is only permitted to modify frames that constitute part of the original request. Thus, processing system **507** may access locations LOC101, LOC102, LOC103, LOC104 and LOC105 in this particular example but it is not permitted to access any other positions within disk storage system **512**.

At step **610** a question is asked as to whether the access has completed and if answered in the negative control is returned to step **609** thereby permitting further access at full bandwidth. Various tests may be included within step **610** to determine when the transfer should be completed. Preferably, full bandwidth access to storage systems should be returned to their host processors as soon as possible and only switched over to other processors when specific data transfers are required.

When the question asked at step **610** is answered in the affirmative, an acknowledgement of completion is issued by processor **507** to processor **502** and processor **501** at step **611**, resulting in switch **521** being activated to reconnect storage system **512** with its host processor **502** and also instructing processor **502** to the effect that the switchover has taken place. Consequently, processing system **502** may now take full control of its associated disk storage system **512**. Thereafter, the thread ends at step **612**.

The data request demon executed by each of the processing systems **501** to **508** is detailed in *Figure 7*. As is known with technology of this type, the program remains resident but not executing until called upon to do so by an external request. The residency of the thread is illustrated by step **701**.

The process is initiated at step **702** upon receiving an interrupt to the effect that a data access is required. At step **703** a question is asked as to whether access can be given and if answered in the negative, an instruction to the effect that access is not available is returned to the requesting processor over Ethernet **551**. Thus, following the previous example, processor **502** will deny access to processor **507** if processor **502** requires full bandwidth access to its own local storage system **512**. Alternatively, if full bandwidth access is not required, it may be possible to allow the requesting processor (processor **507**) to gain access through the fibre channel switch **521**. If access is not available, the thread terminates and stays resident at step **705** returning it to the resident state **701**.

If access can be given the question asked at step **703** is answered in the affirmative and control is directed to step **706**. The requesting host generates a frame identification and the requested identification is identified at step **706**. The processor then makes reference to its superblock allowing it to return details of storage locations at step **707**.

After returning the storage locations; the host processor effectively hands over access to its local disk storage system. The philosophy of procedures executed by the host system is that other hosts should not be allowed access for long. Consequently, at step 708 a question is asked as to whether access has been returned, implemented by a completion acknowledgement generated at step **611**. If access has not been returned, the question asked at step **708** is answered in the negative and a question is asked at step **709** as to whether a call should be made to actively request return of the access. If this question is answered in the negative, control is returned to step **708**.

If the local processor determines that another host processor has

retained access for too long, resulting in the question asked at step **709** being answered in the affirmative, a request is issued at step **710** for the return of disk access. This should then result in access being returned whereafter the demon may terminate and stay resident.

Ideally, host processors should allow other processors access for periods allowing them to do useful work therefore under ideal conditions access should be returned before the host processor demands it, resulting in the question asked at step **708** being answered in the affirmative. This results in control being returned to the local processor and again the thread terminates at step **711**.

In the network environment shown in *Figure 5*, all of the processing systems **501** to **508** are substantially similar and are implemented on the Silicon Graphics Octane platform. Manipulations upon image data, using software applications such "FLAME" and "FIRE" licensed by the present Assignee, may be executed to perform manipulations upon standard bandwidth video material. However, in many environments, higher bandwidth images are processed, such as those for high definition television or for those generated by scanning cinematographic film. Similarly, stations of lower capability are also provided, possibly for manipulating lower bandwidth material, off-line editing or for performing simple manipulations upon data, possibly loading data into the environment from video tape.

An alternative environment is illustrated in *Figure 8*. Fibre channel switch **801** is substantially similar to switch **521** and storage system **802** to **809** are substantially similar to systems **511** to **518**.

Storage systems **802** to **809** are connected to fibre channel switch **801** over respective fibre channel interfaces **812** to **819**. These are substantially similar to interfaces **541** to **548** and result in a further eight interface nodes

being available on switch for communication to processing systems. Four interface nodes of the fibre channel switch **801** are connected by interfaces **821** to a Silicon Graphics Onyx2 computer **822**. These four fibre channel communications are connected, by default, to storage system **802** to **805**. This provides full bandwidth transfer of high definition television signals between storage and the Onyx2 computer or it provides several full bandwidth channels of lower definition signals, such as standard broadcast video. This represents top-end image processing capability but, as such, would incur substantial time charges within a facilities house.

In known environments employing top-end equipment, it is known that time may be taken on the equipment merely to load source material into the environment or to download completed material from the environment. Under these circumstances, many of the capabilities of the top-end facility effectively becomes redundant and is thereby a substantial overhead.

In the environment shown in *Figure 8*, Onyx2 computer **822** acts as switch master and as such allows the Onyx2 to perform a reconnection such that interfaces **821** are connected to storage systems **816** to **819** instead of being connected to storage systems **812** to **815**. An advantage of performing a switchover of this type is that while the Onyx2 computer **822** is performing top-end operations using data stored in storage systems **802** to **805**, data may be removed from storage systems **806** to **809** and new material may be loaded to these storage systems. Eventually, a particular job will complete and finished material will reside on storage systems **802** to **805**. It is now necessary to remove the data from these storage systems but this is a relatively lowly task to be performed on the Onyx computer. Consequently, a switchover occurs such that the Onyx2 computer may now manipulate material stored on systems **806** to **809**. The transfer of completed data from

storage systems **802** to **805** and its replacement with new source material is performed by an alternative system.

In addition to Onyx2 computer **822**, an octane-based system **824** is connected to the fibre channel switch **801** via an interface **826**. Onyx system **822** and octane system **824** communicate with the fibre channel switch **801** over an Ethernet network **827**. Octane system **824** is substantially similar to the data processing system shown in *Figure 5*, with the addition of a second Ethernet network **828**. This in turn has four off-line systems **831**, **832**, **833** and **834** connected thereto. The off-line systems are primarily configured to facilitate the loading of video information such that this loaded information may then be manipulated by the Onyx2 system in real-time. In addition, modest housekeeping manipulations may be performed by systems **831** to **834** and these systems may also be configured to perform off-line editing procedures upon compressed representations of video frames.

Thus, in the environment shown in *Figure 8*, any of systems **824**, **831** to **834** may be involved with the transfer of data to the storage systems **802** to **809**. In a preferred arrangement, the Onyx2 system **822** remains almost constantly in operation and is given access to sub-set **802** to **805** of the storage systems or to sub-set **806** to **809** of the storage systems. When using storage systems **802** to **805**, storage systems **806** to **809** may be accessed by the secondary system **824** or by the tertiary systems **831** to **834**. Off-line station **831** may be allocated the task of ensuring that the Onyx2 system **822** is kept busy such that while working on a sub-set of disks an off-line operator at station **831** must ensure that data is maintained in the complimentary sub-set of disks. In this way, a handover may occur whereafter the off-line operation at station **831** would be responsible for releasing process data and the loading of new data to ensure that a further

handover could take place and so on thereby optimising availability of the Onyx2 system.

Off-line processing system **831** is detailed in *Figure 9*. New input material is loaded via a high definition video recorder **901**. Operation of recorder **901** is controlled by a computer system **902**, possibly based around a personal computer (PC) platform. In addition to facilitating the loading of high definition images to storage systems, processor **902** may also be configured to generate proxy images, allowing video clips to be displayed via a monitor **903**. Off-line editing manipulations may be performed using these proxy images, along with other basic editing operations. An off-line editor controls operations via manual input devices including a keyboard **904** and mouse **905**.

Data processing system **822** is illustrated in *Figure 10*, based around an Onyx2 computer **1001**. Program instructions executable within the Onyx2 computer **1001** may be supplied to said computer via a data carrying medium, such as a CD ROM **1002**.

Image data may be loaded locally and recorded locally via a local digital video tape recorder **1003** but preferably the transferring of data of this type is performed off-line, using stations **831** to **834** etc.

An on-line editor is provided with a visual display unit **1004** and a high quality broadcast quality monitor **1005**. Input commands are generated via a stylus **1006** applied to a touch table **1007** and input commands may also be generated via a keyboard **1008**.

The environment described herein allows a plurality of disk storage systems to be accessed by a plurality of host processors at full bandwidth. Furthermore, the procedures for effecting a handover via a full bandwidth switch ensure that the integrity of data contained within the system is

maintained. In particular, a host processor retains control of a particular disk system and requests must be made to the host processor in order for a remote processor to gain access thereto.

Claims

1. A networked image data processing environment, comprising

a plurality of image data processing systems;

a plurality of data storage systems, wherein each of said data storage systems is operated under the direct control of one of said image processing systems;

a high bandwidth switching means connected to each of said data processing systems;

a low bandwidth network connecting said image processing systems and to said switching means, by which one of said processing systems controls the operation of said switching means, and in which

a first processing system requests access to a data storage system controlled by a second processing system over said low bandwidth network;

said second processing system makes an identification of storage regions that may be accessed by said first processing system and to each of said storage systems;

said second processing system conveys said identification to said first processing system over said low bandwidth network; and

said first processing system accesses said identified storage portion via said high bandwidth switching means.

2. A processing environment according to claim **1**, wherein said data processing systems are based around a silicon graphics O_2, Octane or Onyx2 computer.

3. A data processing environment according to claim **1**, wherein

said data storage systems include a plurality of disks configured to receive image stripes.

4. A data processing environment according to claim **3**, including redundant disks to provide data security.

5. A data processing environment according to claim **4**, wherein said disks are configured as a redundant array of inexpensive disks (RAID).

6. A data processing environment according to claim **1**, wherein said high bandwidth switching means is a fibre channel switch.

7. A data processing environment according to claim **1**, wherein said low bandwidth network is an Ethernet network.

8. A data processing environment according to claim **1**, wherein said processing systems execute programs to identify requests made by other processing systems.

9. A data processing environment according to claim **1**, wherein at least one image data processing system has direct control of a plurality of data storage systems.

10. A data processing environment according to claim **9**, including lower powered data processing systems that are configured to supply image data to image data processing systems connected to said high bandwidth switching means.

11. A method of transferring data in a networked image data processing environment, including a plurality of image data processing systems, a plurality of data storage systems, a high bandwidth switching means connected to each of said data processing systems and to each of said storage systems, and a low bandwidth network connected to said image processing systems and to said switching means, by which one of said processing systems controls the operation of said switching means, wherein said method performs the steps of:

operating each of said data storage systems under the direct control of one of said image processing systems;

issuing a request from a first processing system to access a data storage system controlled by said second processing system over said low bandwidth network;

making an identification at said second processing system of storage regions that may be accessed by said first processing system;

conveying said identification from said second processing system to said first processing system over said low bandwidth network; and

accessing said identified storage portion by said first processing system via said high bandwidth switching means.

12. A method according to claim **11**, wherein said data processing systems are based upon a Silicon Graphics O_2, Octane or Onyx2 computer.

13. A data processing environment according to claim **11**, wherein said data storage system includes a plurality of disks configured to receive image stripes.

14. A method according to claim **13**, including redundant disks to provide data security.

15. A method according to claim **14**, wherein said processing systems are configured to write data to said array of disks and read data from said array of disks using RAID protocols.

16. A method according to claim **11**, wherein said high bandwidth switching means is a fibre channel switch.

17. A method according to claim **11**, wherein said low bandwidth network is an Ethernet network.

18. A method according to claim **11**, wherein said processing systems execute programs to identify requests made by other processing systems.

19. A method according to claim **11**, wherein at least one image processing system has direct control of a plurality of data storage systems.

20. A method according to claim **19**, including lower powered data processing systems that are configured to supply image data to image data processing systems connected to said high bandwidth switching means.

21. A computer-readable medium having computer-readable instructions executable by a computer such that, when executing said

instructions, a computer will perform the steps of

directly controlling a local disk storage system;

issuing a request to access a data storage system controlled by a second processing system over a low bandwidth network;

receiving an indication from said remote processing system identifying storage locations that may be accessed on said second storage system;

accessing said data portions through a high bandwidth switching means connected to each of said processing systems and to each of said storage systems.

22. A computer-readable medium having computer-readable instructions according to claim **21**, such that when executing said instructions a computer will perform RAID calculations when writing data to a locally controlled disk and when reading data from said locally controlled disk.

23. A computer-readable medium having computer-readable instructions according to claim **21**, such that when executing said instructions a computer will issue said requests over an Ethernet network.

24. A computer-readable medium having computer-readable instructions according to claim **23**, such that when executing said instructions a computer will receive said indication over said Ethernet network.

25. A computer-readable medium having computer-readable instructions according to claim **21**, such that when executing said instructions a computer will access said indicated portions through a fibre channel switch.

26. A computer-readable medium having computer-readable instructions executable by a computer such that, when executing said instructions, a computer will perform the steps of

directly controlling a local disk storage system;

responding to a request from a remote data processing system to access said local disk storage system;

identify a portion of said local disk processing system that may be accessed by said remote processing system; and

issuing an indication to the effect that said remote processing system may gain access to said storage system via a high bandwidth switching means.

27. A computer-readable medium having computer-readable instructions according to claim **26**, such that when executing said instructions, a computer will respond to said requests received over a low bandwidth Ethernet.

28. A computer-readable medium having computer-readable instructions according to claim **27**, such that when executing said instructions a computer will issue said indication over said low bandwidth Ethernet.

29. A computer-readable medium having computer-readable instructions according to claim **26**, such that when executing said instructions a computer will perform RAID calculations while directly controlling said local disk storage systems.

30. A computer-readable medium having computer-readable

instructions according to claim **26**, such that when executing said instructions a computer will issue an indication to the effect that said remote processing systems may gain access to said storage systems via a fibre channel switch.

Abstract of the Disclosure

A networked image processing environment has several image data processing systems (**501** - **508**). In addition, there are provided many storage systems (**511** - **518**) in which each of the data storage systems is operated under the direct control of one of the image processing systems. A fibre channel switch (**521**) is connected to each of the data processing systems and to each of the storage systems. A low bandwidth Ethernet (**551**) connects the image processing systems together and is also connected to the fibre channel switch. Under this arrangement, the fibre channel switch is controlled by one of the processing systems. A first processing system requests access to a data storage system controlled by a second processing system over the Ethernet. The second processing system makes an identification of storage regions that may be accessed by the first processing system then conveys this identification to the first processing system, again over the Ethernet. Having received this information, the first processing system accesses the identified storage portion but this time via the high bandwidth switching means. This provides a stable environment which allows host processors to gain access at full bandwidth to storage systems controlled by other hosts processors.

DL-PS38

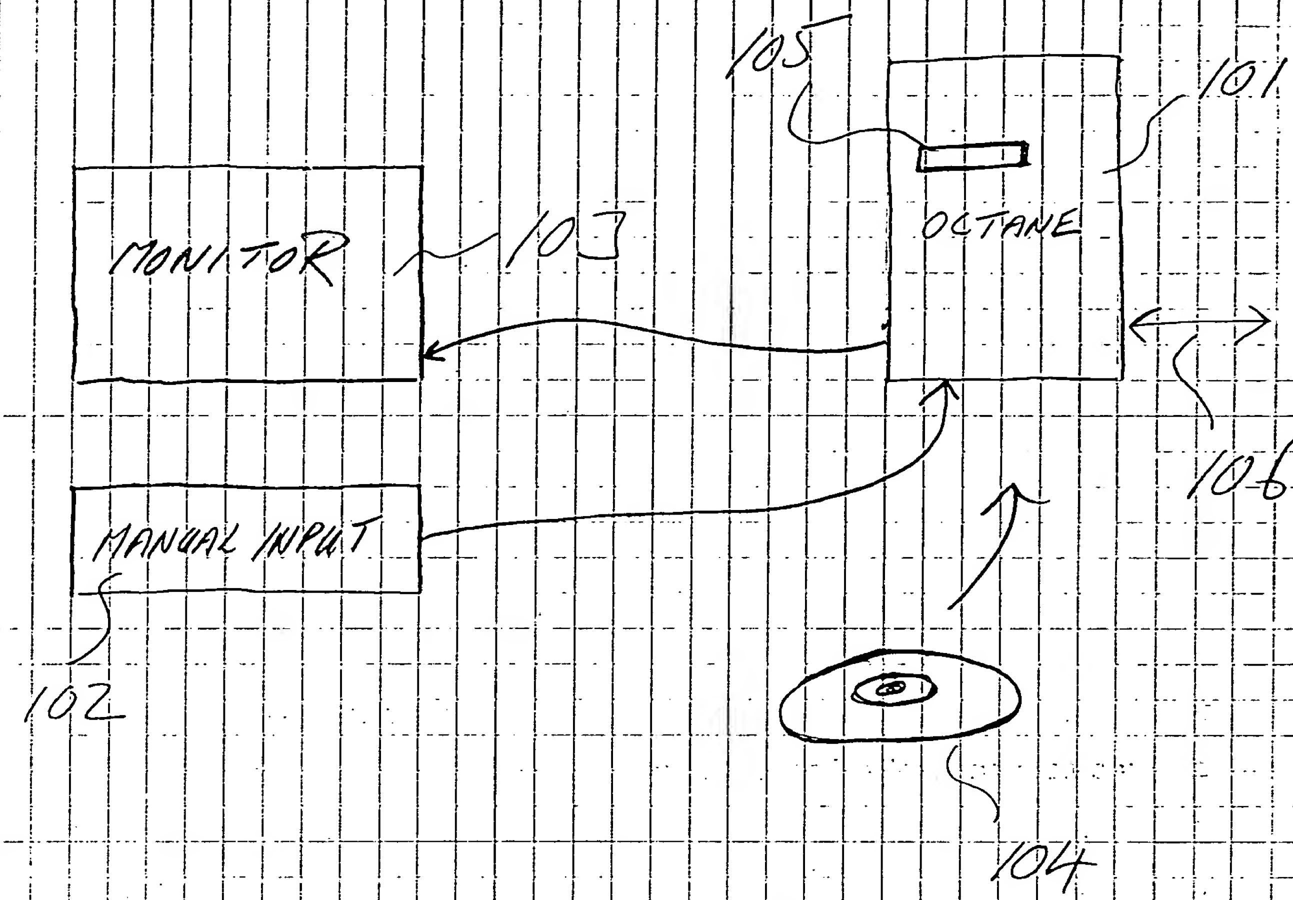
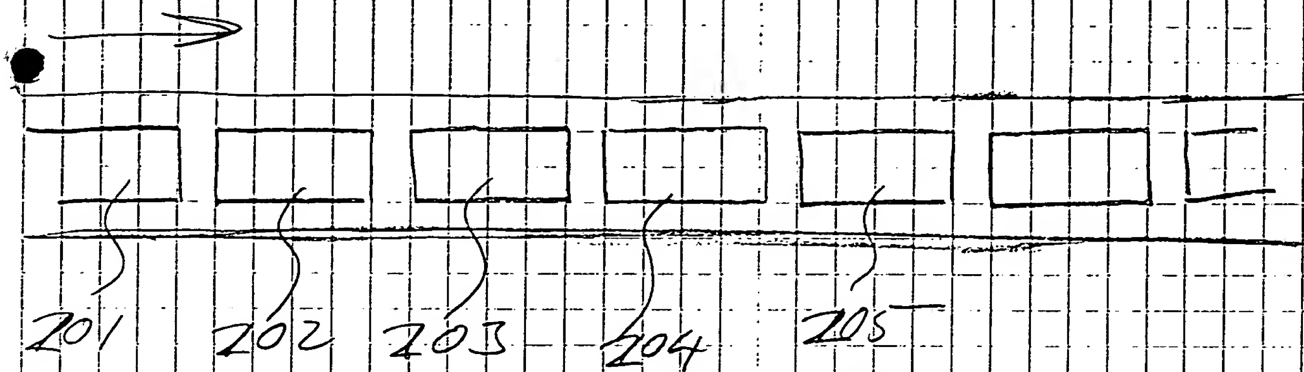


Figure 1

DL-PSJ8



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ID 102	LOC 102
ID 103	LOC 103
ID 104	LOC 104
ID 105	LOC 105

Figure 2

DL-P538

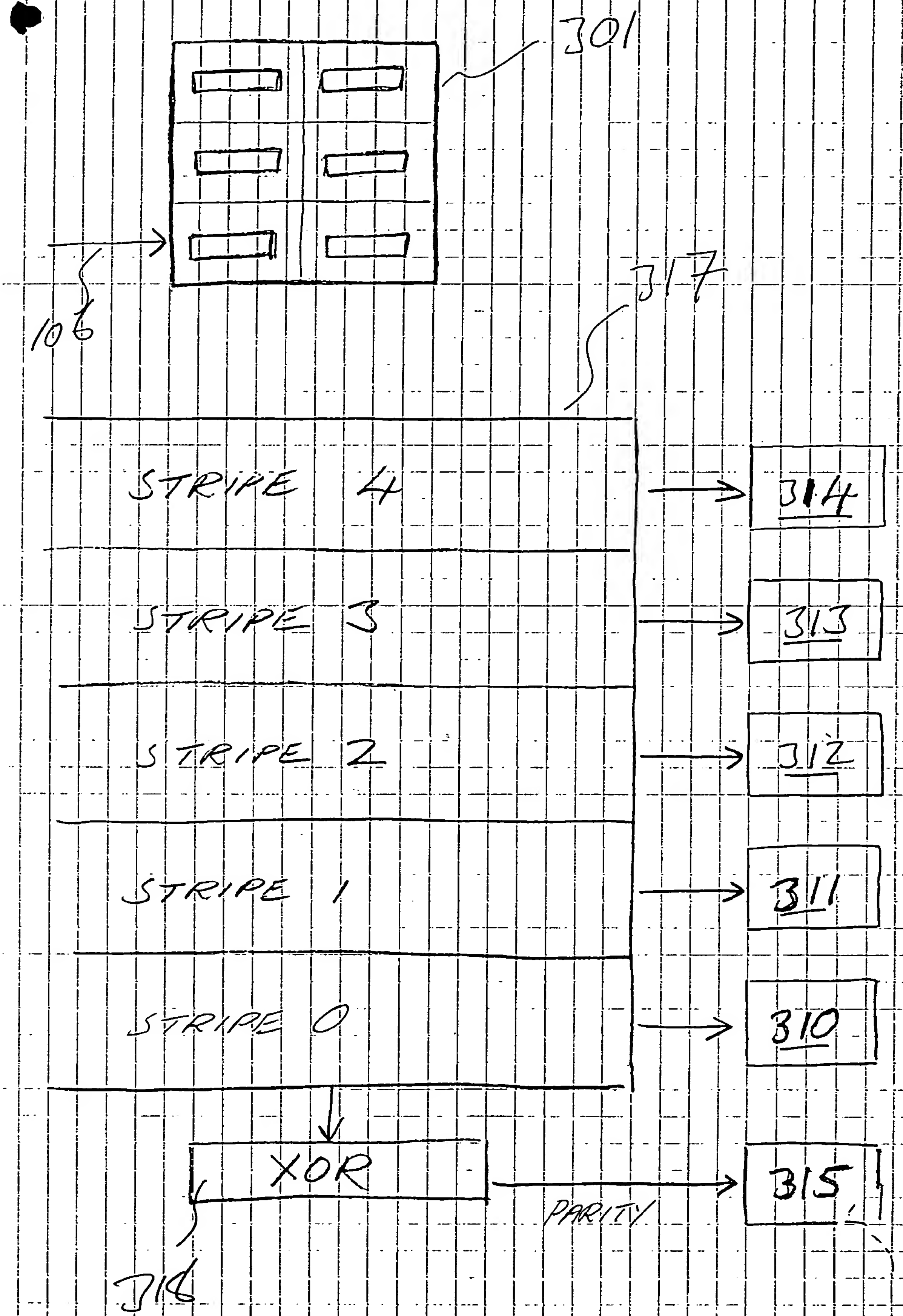

Figure 3

DL-P538

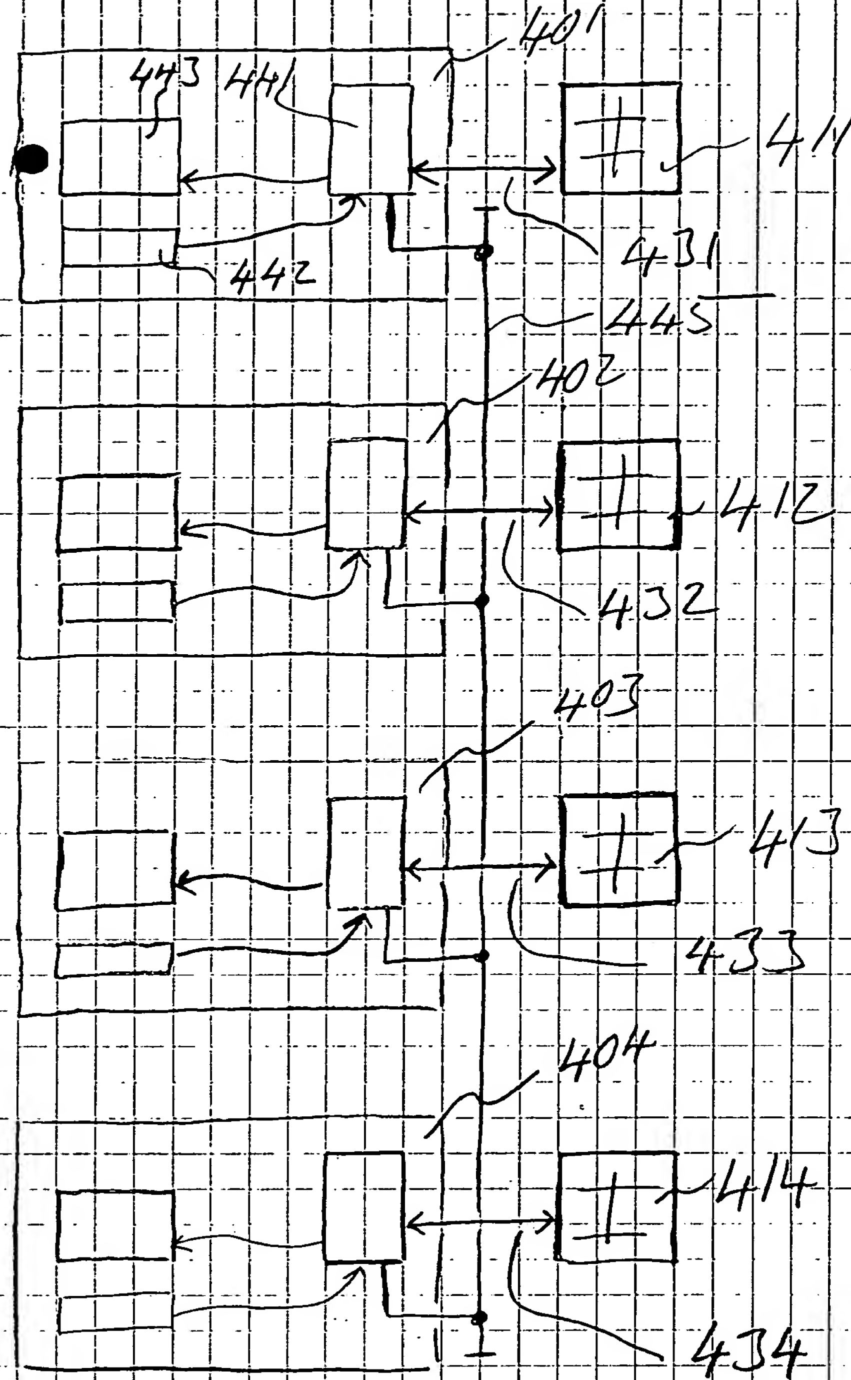

Figure 4

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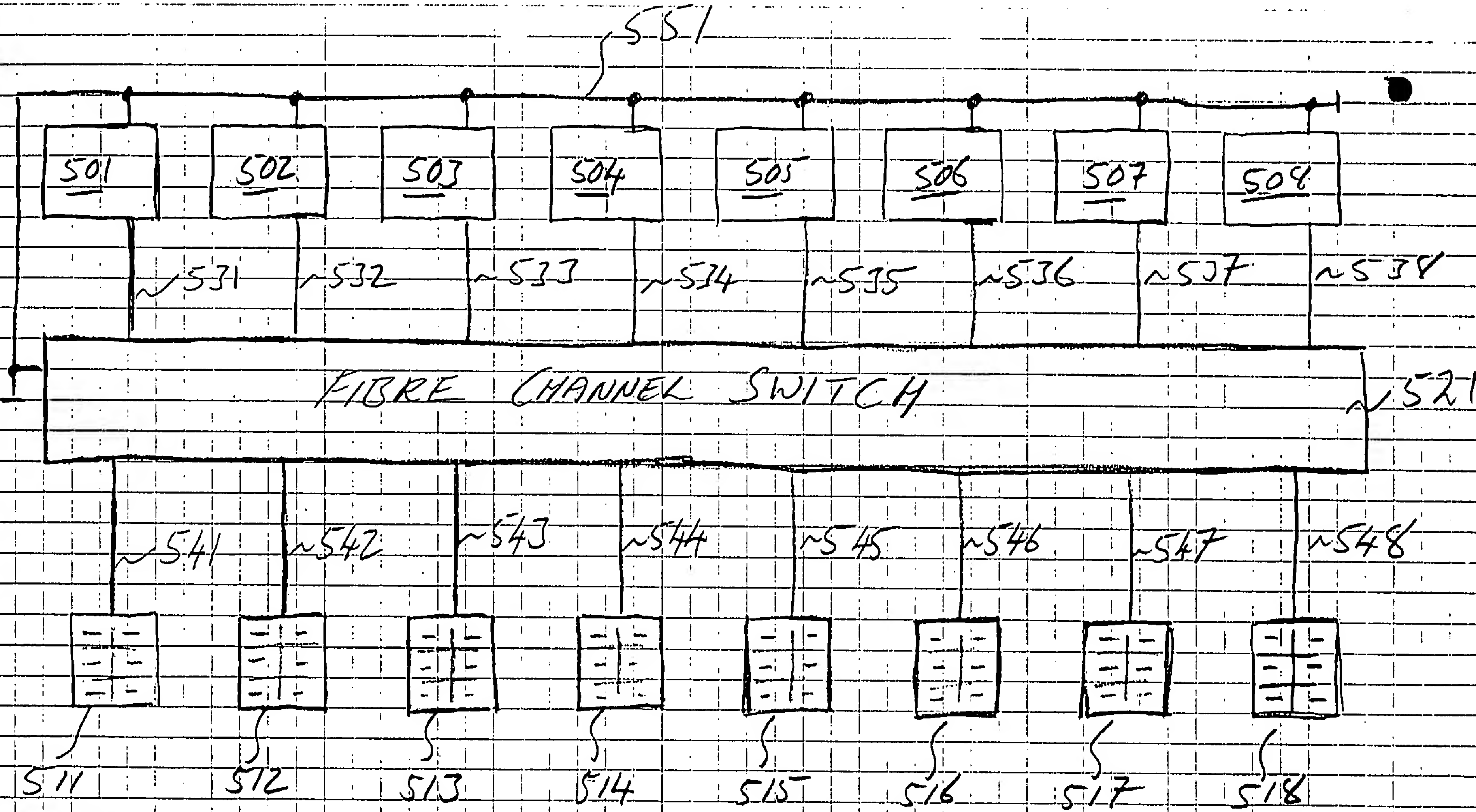

Figure 5

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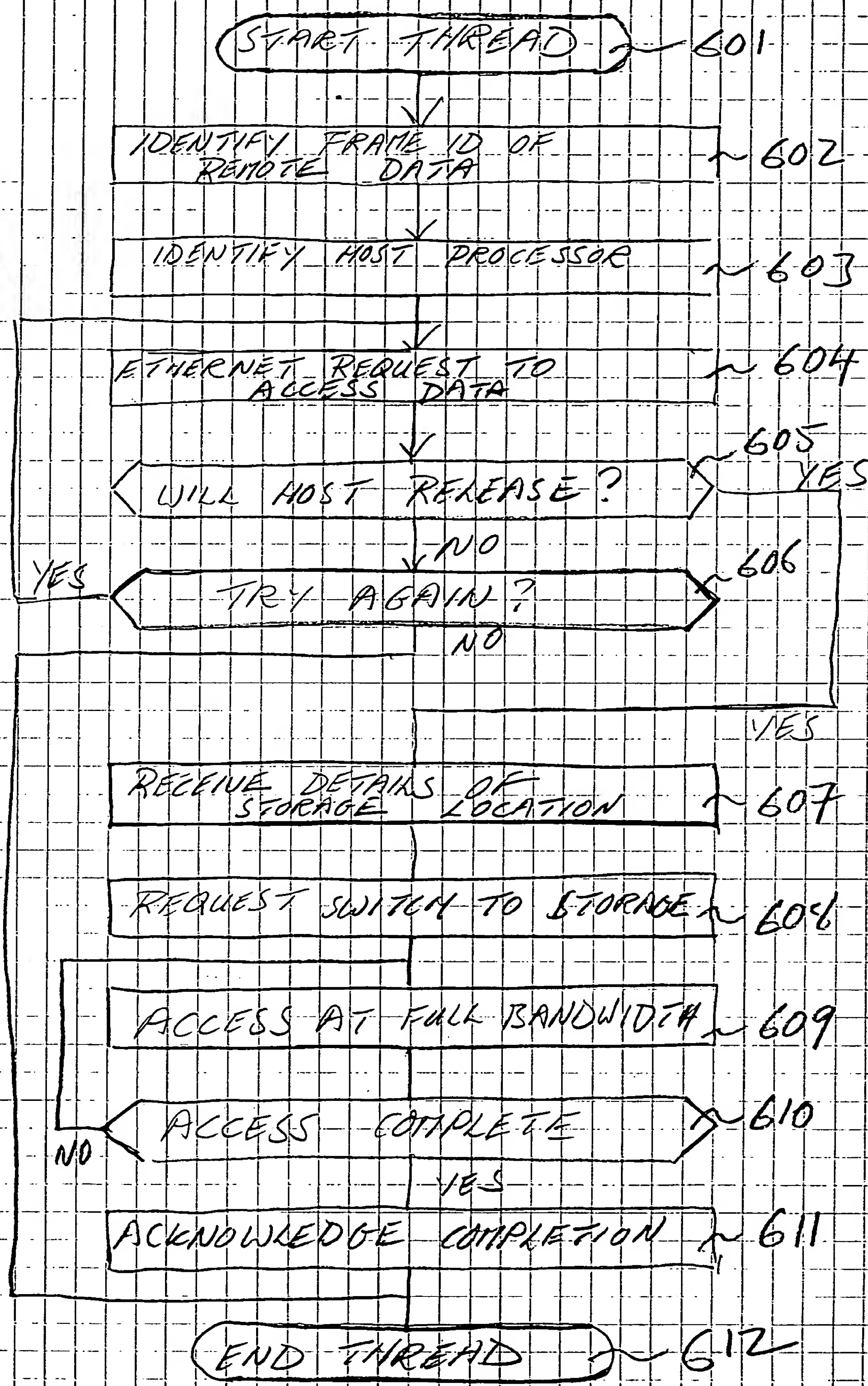

Figure 6

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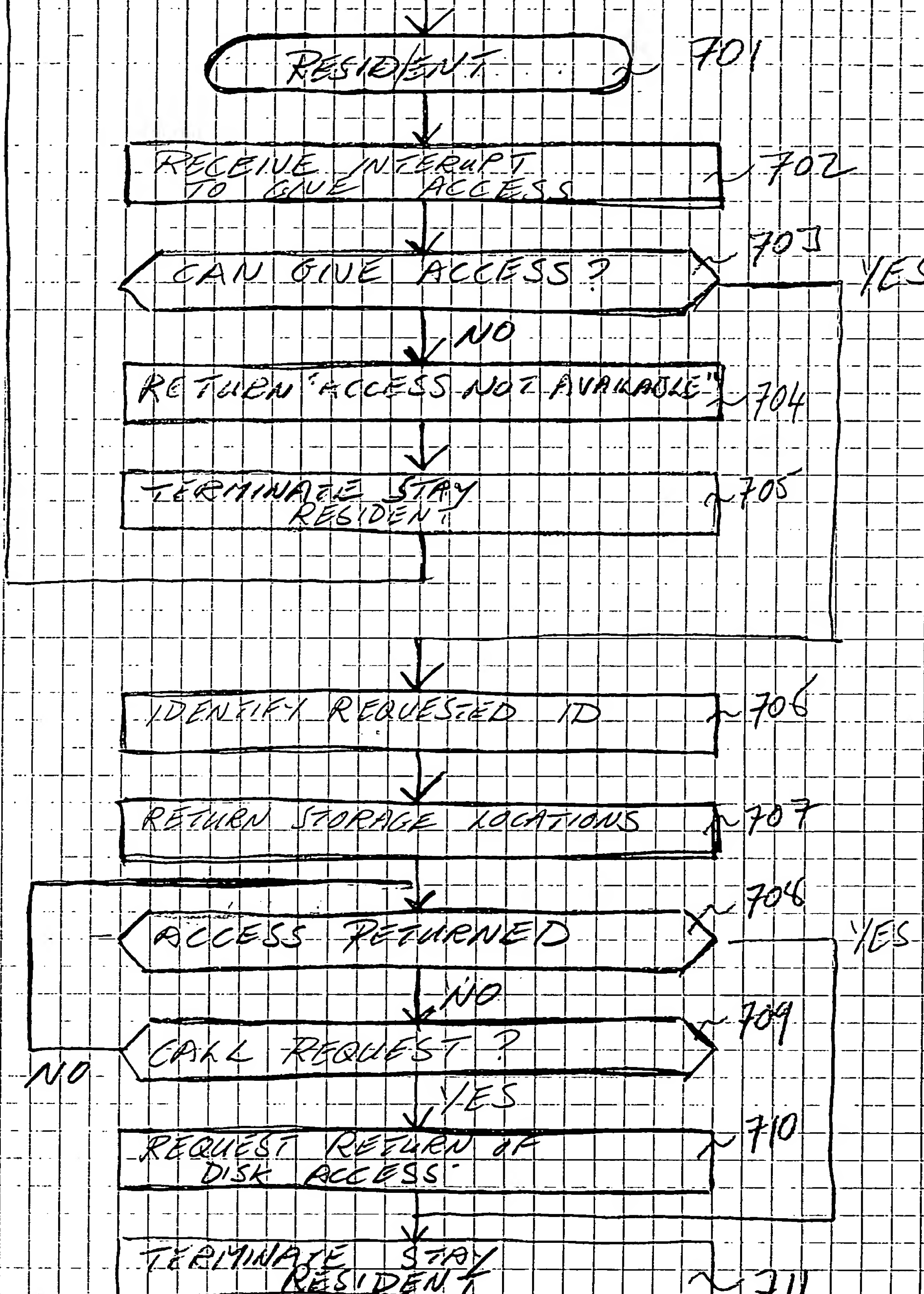

Figure 7

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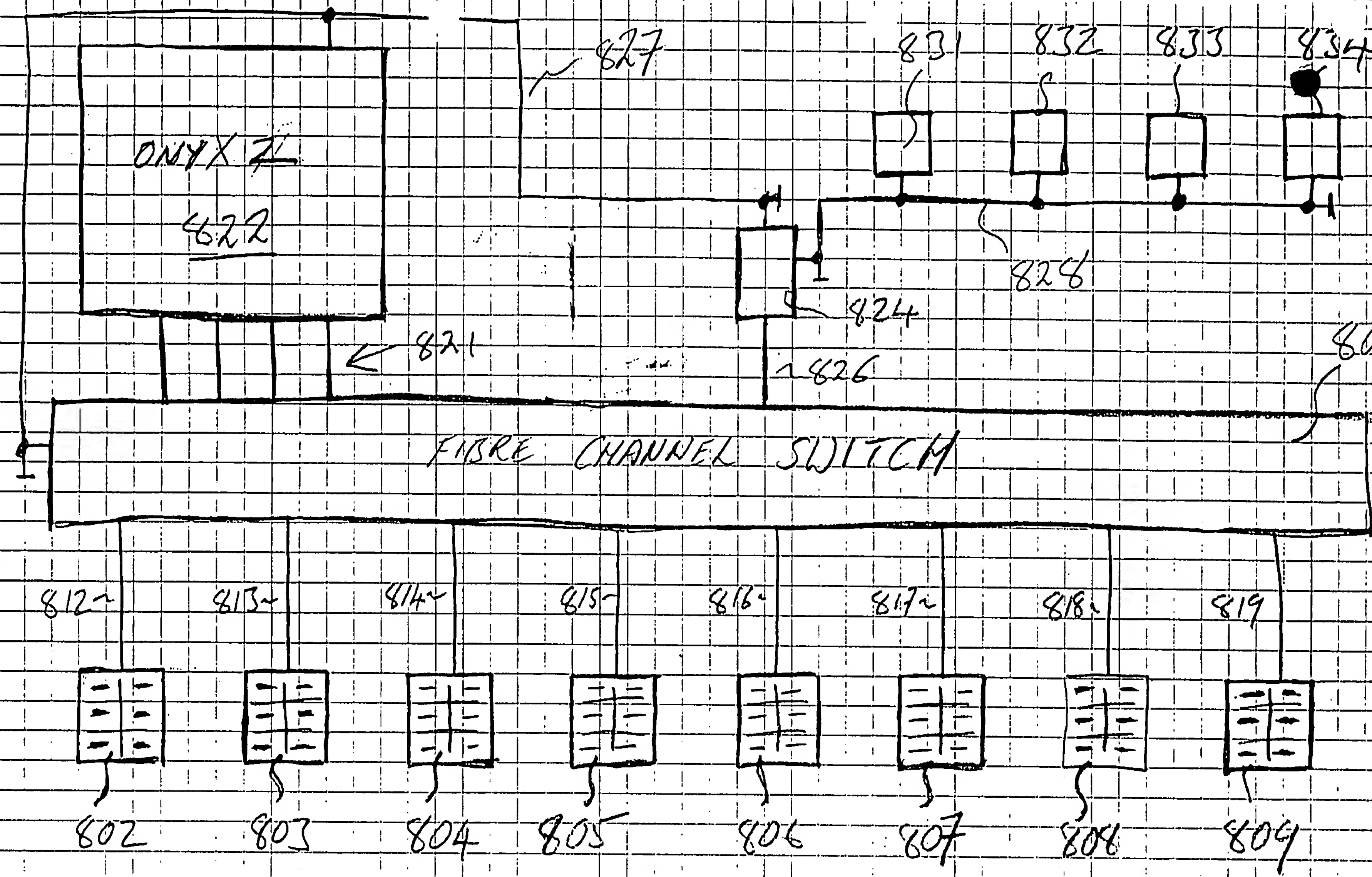

Figure 8

DL P539

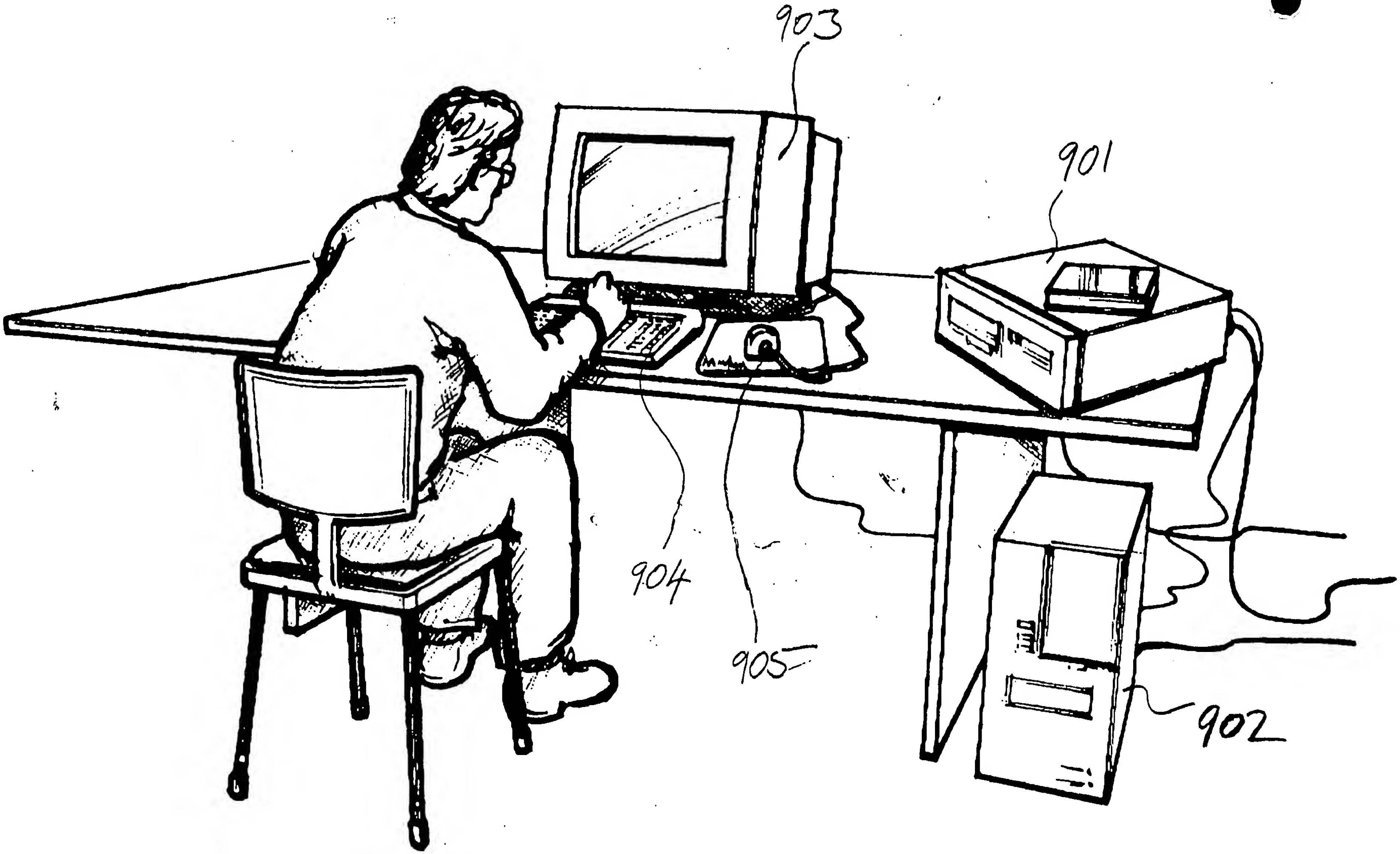

Figure 9

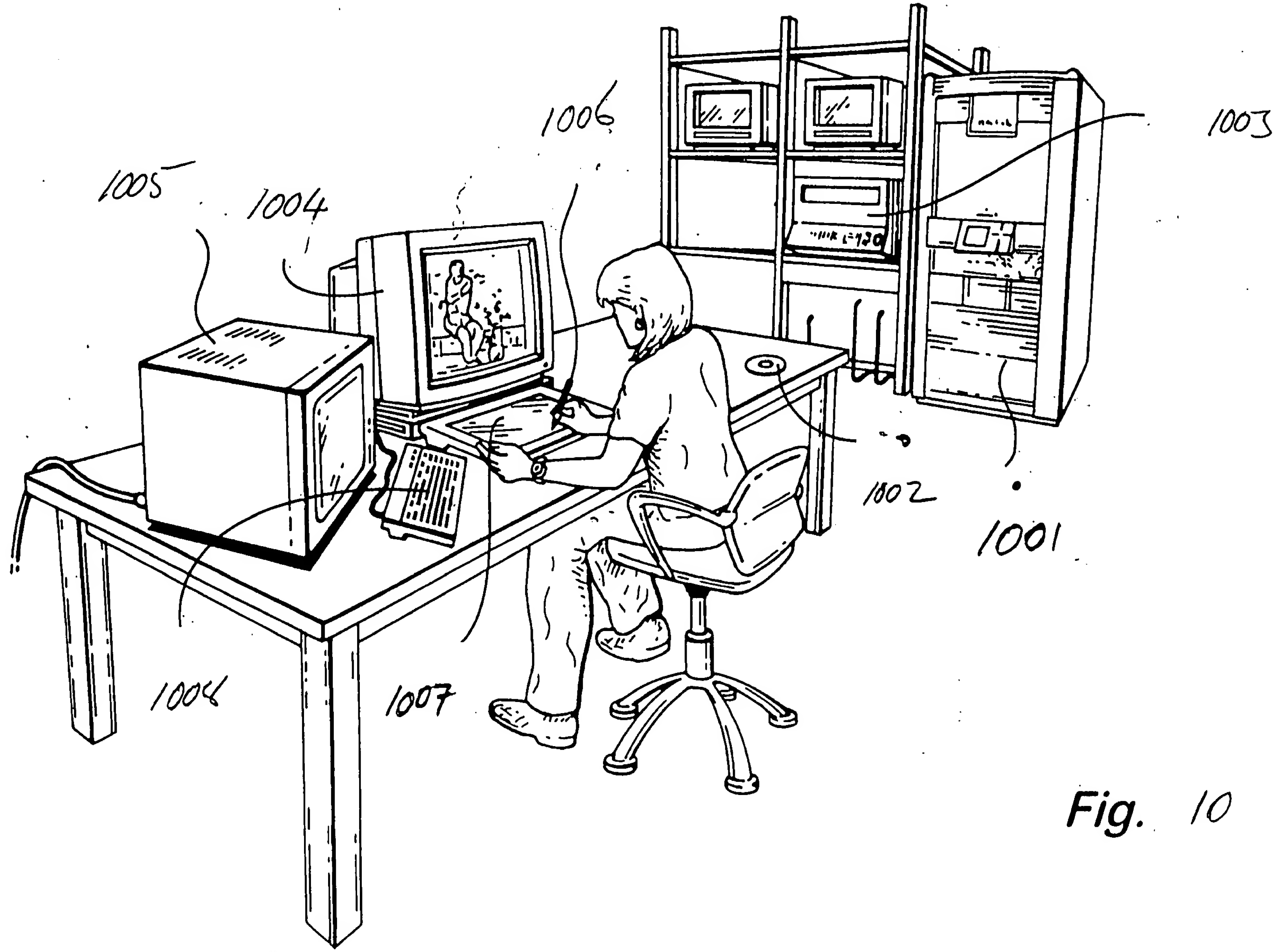

Fig. 10